Method of Operating in the Melter and Refiner's Department of the U.S. Mint at Philadelphia.

Receiving Deposits.

Before the Deposits of Bullion are passed into the hands of the Melter & Refiner, they are received by the Superintendent's Receiving Clerk, in the presence of an Assistant, the Register of Deposits, & the Depositor himself, precisely according to the "Instructions for Transacting business at the Mint", the weights before and after melting being noted and recorded by two or three persons officially. The Register records his observations on the character of the metal deposited, its alleged & origin, its absolute, ~~loss~~ in melting, & its calculated percentage loss. These elements are weekly discussed by the Melter & Refiner, and his Report made to the Superintendent.

The Melter & Refiner has nothing whatever to do with the Deposits until they have been melted, weighed after melting, and assayed, so that their exact value is known, except that, upon the requisition of the Foreman of Deposit-Melting, he may advise or suggest a special mode of melting & fluxing. On the soundest principles the M. & R. should not receive, nor hold a deposit until

until he can be debited with its ascertained value.

Deposits transferred to the Melter & Refiner

The smaller deposits are daily transferred to the M. & R.; the larger deposits, purchases & transfers, ~~are passed to him~~ as soon as practicable after their arrival in the Mint. They are weighed and delivered to the M. & R., in presence of the Register, by the Receiving Clerk, the gross weight being silently observed and recorded by each of the three officials, & the recorded weight then called out in order by the triple concord, to insure accuracy in the record. It has been noticed that where a weight is announced before recording it, there is a tendency to record the announced figures ~~weight~~, not only without observing the weight, but even after observing it, and altho it may be different from the sum ~~that~~ announced; hence the advantage of ~~the above~~ recording before announcement.

over

All the smaller deposits, & as many as ~~far~~ as practicable of the larger ones, after weighing, are immediately transferred the M. & R's vault, but in the present method of receiving large invoices of fine silver bars or pigs, & ~~for want~~ from lack of vault space, the remaining pigs, over 100 lbs. weight each, are stored again in the Supt.dt's vault, until needed for coinage, or until there is space in the M. & R.'s vault to receive

At the close of ~~each~~ weighing each lot of bars, or of each day's weighings, the whole lists are again compared by one reading aloud the noted weights, should any recorded weight lack the triple concord, that particular bar or bars is reweighed.

receive them. In recording the weights of the numerous silver pigs of an invoice, the record shows the Mint number of the deposit, &c., the number & other mark stamped on each bar, and the consecutive numbers painted on each pig ~~by in marking ink~~ by the M. & R. The agreement of weight with markings will always identify each pig; together with this identification & the great weight of each pig precludes error ~~of any~~ or evil of any kind arising from the necessity of storing the pigs in the Treasurer's vault, altho' officially they are in the hands of the M. & R.

After each transfer of bullion, the M. & R. gives to the Superintendent a Receipt for the Gross weight and character of the bullion received. The M. & R. is however debited, according to law, only with the Standard Weight of Bullion, as soon as calculated from the gross weight & assay-fineness, by two of the Treasurer's clerks, (separately and by different methods.) When in active business, the M. & R. has not sufficient clerical force to calculate the standard weights, otherwise a third calculation ~~would be~~ is desirable & should be made.

Refining Bullion

The Deposits are assorted into fine & standard, which are melted into coin, ~~after proper to~~ and into those which ~~are to~~ require

require to be refined by acids, in order to adapt them to ~~make~~ coinage. Even some Silver Bullion containing ~~chiefly~~ copper as its alloy & in so far adapted to coin directly, may yet be so hard & brittle from the presence of minute quantities of embrittling metals as to ~~require~~ make refining by acid, ~~as~~ more economical & effective than toughening by fluxion. Every gold deposit, reported by assay to contain silver, is subjected to refining by acid.

Refining over Gold. ¶ Gold deposits are assorted into lots, according to fineness, and so much silver added to each, that the ratio between gold & silver ~~(including baser metal)~~ shall be about 1 : 2. Our usual melt of 2400 oz. therefore consists of about 800 oz. pure gold, and 1600 oz. Silver ~~(baser metal)~~. After being melted and thoroughly and continuously stirred by a black lead stirrer to insure the dissemination of the gold through every part of the alloy, the latter is dipped out by a black lead dipping cup, & either cast into bars of about 10 @ 15 lbs. weight, or granulated. ¶ In the last method it is cast from the height of several feet, & with a horizontal gyratory motion, into a large bulk of very cold water (in summer cooled by ice), whereby it congeals in thin feathery granules, presenting a greatly extended surface. The bars or granulations are steamed for some five hours in commercially pure nitric acid of 35° @ 40°

but if there be much base metal (such as copper) with the silver, the weight of the two together may reach 2¼ or more 2½ to 1 of gold, ~~&c~~

¶ Native gold (crude or melted) and gold residues from the arts ~~when melted~~ contains more or less silver, which, being of no value in gold coin, is previously extracted by parting, or refining ~~by acid~~ by the chemical agents, ~~usually by~~ nitric acid, or oil of vitriol, or chlorine. In this mint we prefer ~~to acid~~ refining by nitric acid, as yielding ordinarily a softer gold, of 994 @ 996, ~~or to chiefly by nitric first by~~ & where we deem it expedient, we finish this ~~same~~ by hot oil of vitriol, thereby raising the fine gold to 998 @ 999½ & recovering that ~~small~~ remnant of silver, the difference between 994 & 998. ~~The method of refining~~ Now the acids will not extract from native gold the small proportion of silver in it ~~in gold~~, & hence the admirable ~~quartation~~ method of the alchemists termed "quartation", wherein one ~~part or~~ ounce of gold was melted with three ounces of silver, the gold constituting a fourth part (a quarter), & so disseminated or diffused among the 3 parts of silver, that hot nitric acid, or oil of vitriol which dissolves silver, but not gold, will dissolve not only the silver that ~~which~~ was added to the gold, but also that which was originally contained in the gold. The only change we have made in this process is ~~the~~ by diminishing the ~~quant.~~ proportion of silver, ~~from 3 to 2 parts~~ making it about 2 ~~part~~ oz. silver to 1 oz. gold, [illegible] [illegible] a change which I introduced in 1850, & which we have adhered to ever since, as being much more economical than the older method of quartation, & yet equally efficient.

@ 40° Beaumée in 20 gall. porcelain jars, the unsaturated acid of the previous operation being used economically on fresh metal to form a saturated solution of nitrate of silver. The solution is drawn off from the insoluble residue of tolerably fine gold, & is converted into fine silver, as below.

¶. The gold residue, after washing with water, is either ~~treated~~ steamed ~~treated~~ a second time with ~~nitric~~ pure acid, ~~& steam~~ whereby the gold is obtained of the fineness of 995, & the nitric acid reserved for the next lot of granulations; or the washed gold residue, whether treated the second time with nitric acid or not, is heated in iron boilers with oil of vitriol, usually in two successive charges, whereby it is brought, after washing, pressing, & drying ~~&~~ and melting, to 998 @ 999 ÷.

Refining Silver. All silver bullion containing gold, and even such as, without gold, is assumed to be more economically than ~~require~~ refined by fluxing acids, is refined by dissolving ~~in hot nitric acid~~ acid, with the same nitric acid, in the same jars, & in the same way, ~~abo~~ as above described for parting gold & silver. The saturated solution of nitrate of silver ~~solution~~ is transferred to a large wooden vat containing a sufficient quantity of a solution of common salt, so that every practicable trace of silver is precipitated as experience dictates, an excess being always employed. The chloride of silver, made to settle by agitation, is run off into large filters, washed until the washings cease to redden

redden litmus paper, and transferred into a lead-lined wooden vat, where it is reduced to metallic silver by granulated zinc of the best commercial quality. ~~A large excess~~ A large excess of zinc is employed to shorten the time of reduction, & the excess dissolved out by sulphuric acid. The pulverulent reduced silver is ~~filter~~ washed thoroughly on a filter by hot water, until the latter ceases to give an acid test, after which it is drained, pressed, dried & melted, yielding bar silver of .998 @ 1.000. by melting, without or with very little fluxing. (over)

Up to the year 1851 ordinary zinc being used, I had ~~used~~ for refining gold ~~employed, I had~~ many tons of silver ~~used for refining gold~~ which averaged about 995, but upon introducing ~~using~~ only the best zinc, which I had cast especially for this Mint in Belgium, the average fineness rose immediately to 998. Now, with the best American zinc, we attain the fineness of 999 ~~or th~~ or higher without difficulty, and in the year 1870 we delivered to the public 83,549 oz. of silver bars, 1000 fine, which means absolute purity. (We believe it to be the only instance on record in which more than 20 or 30 oz. of silver was made of absolute purity at one period of time.)

Pressing and Drying ~~Rolling~~ pulverulent gold & silver into a compact mass ~~is recommended~~ was adopted by me in 1850, as a remedy against their loss ~~by~~ in the form of dust, & has amply repaid the cost of the ~~machine~~ arrangement. If the powdered metal, however thoroughly dried by warmth, be put into the melting pot, it boils, often

The operations of precipitating, ~~&~~ washing & reducing chloride of silver, & ~~was~~ of washing the reduced silver may ~~by~~ be so facilitated by mechanical appliances, as to reduce the time of recovering ~~pure~~ silver ~~in the~~ ~~metallic~~ state form from its solution from 48 or more hours to ~~5 or 6 hours~~ less than six (6) hours.

often violently, from the escape of steam, which carries the fine dust up the chimney flue & some of it out of the chimney into the air. To obviate this danger of loss the reduced and washed ~~silver~~ metal is pressed in a powerful hydraulic press into flat cylinders or cakes, which are dried on a shallow pan of heavy boiler-iron at a low red heat, until a piece of sulphur passed across the ~~cake~~ cake leaves its blue line of flame, indicating sufficient dryness. The ~~cakes~~ cakes, weighing 35 or 40 lbs. in silver, & nearly twice as much in gold, are simply broken by hammer & chisel into lumps which are directly melted in a crucible with a little borax ~~flux~~ into bars of ~~pure~~ fine silver.

Refining Account. A special refining account is kept by debiting the Refinery with all the gold & silver sent into ~~the Refinery~~ it, each bar or lot being entered separately into the account in gross weight, fineness and standard weight. The Refinery is credited with all the gold & silver, refined, melted, weighed, assayed, & calculated to standard, which it returns to the vault. A summary of the Refining appears also ~~in~~ as a special item in the Vault Account. The balance between the Dr & Cr, shows that in general the act of refining is attended with little loss. Where the deficit is larger than ~~[illegible]~~ it should be, a minute investigation discovers the cause of the apparent or real loss, & thus indicates a remedy when ~~when~~ it may be needed.

melting

Melting Standard Ingots

The U.S. standard for gold and silver being 900 m pure to 100 m alloying metal, the relative quantities of these must be calculated and weighed out for a given quantity of alloy, ~~the highest limit of which that~~ that quantity which is melted in a crucible at one time. The quantity of precious metal in each mass of silver from the mines is determined by assay, ~~the balance is the is expressed as such & such fineness, meaning the member parts of pure metal in each 1000 parts of the mass;~~ and is the balance is assumed to be alloying metal, oftener expressed as alloy. Since the different pigs, or bars, or lumps of ~~met crude met~~ bullion vary in fineness, each melt requires ~~an or more calcu~~ a separate calculation for each pigs, of which it is to be composed. When the standard Ingots, cast from a melt, are rolled into strips, & the coin-disks clipped out the ~~small disks or blanks for coin are cut out of them, the residue~~ residue, termed clippings, ~~from clipping from cutting out the small disks for coin, are to~~ is returned to the M & R. ~~To be remelted~~. In point of fact, about one half of the standard metal is thus returned, to be remelted, & in like manner the half of each successive residue. Hence each piece of metal is thus melted $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} +$ &c. ~~and &.~~ number of times. ~~$\frac{1}{2}$ and $\frac{1}{8}$ and $\frac{1}{16}$ &c.~~ The sum of an infinite series of ~~one~~ 1 successively halved being just equal to 2, all the standard ~~metal~~

~~metal~~ standard metal melted for coinage, is melted at least twice.

~~For the reason just stated~~ In calculating & making up a melt for ingots, only about one half of the amount of new metal is used, & the other half consisting of clippings from previous workings, for experience has shown that clippings tend to soften newly made alloys

The M. & R. ~~assistant M. & R.~~ weighs out the due quantity of bullion for a melt, he & the weigher reading the weight separately, to insure accuracy, ~~has the weight twice read, by himself and the weigher~~, and enters the weight in the "Working book", arranged for the purpose, and puts the bullion so weighed into a copper-lined box. The M. & R., having calculated accurately the amount of copper or fine bullion, (as the case may be,) required to bring each melt to standard fineness, weighs it out, & adds it to the box containing that melt. The gold and silver being usually in bars, (incapable of minute subdivision) the weight of copper is made flexible, & by having a stock of it divided into assorted fragments down to .01 oz. and less, ~~to 100~~. The best commercial copper, (99½ @ 99¾ pr. ct. pure, by analysis of extreme accuracy), occurring in bars of 12 @ 15 lbs. weight, is partly cast into bars of ⅛ @ ¼ inch thickness, & some of these again sheared into smaller clips, and partly is cast into very cold water (using ice in Summer) to granulate it into shot of every conceivable size, from fine sand to

~~that of~~ over

Buck-shot. A special account is kept of the copper used for alloying Gold and Silver.

The calculation of the quantity of alloying copper, or of fine bullion, requisite to make standard metal, is made by the M. & R. or Assistant M. & R., because extreme accuracy is desirable, and, when business is very active, rapidity is also needed. Only one person however seems to be necessary for the calculation, for we have not found a single error in many thousand of our calculations.

When a carload of such melts is made up (usually 10 @ 15 melts, or when business is very active ~~2~~ two or more carloads) it is drawn into the vault, to be taken out for melting on the following morning.

Making Gold Ingots

Black Lead crucibles of № 70 size are used to melt the alloy for ingots, the total weight of each melt being 4000 @ 4500 oz. of standard gold (900 fine). The quantity of copper, calculated to bring all the gold exactly to 900 fineness, is weighed with precision to the 1/100 oz., and the weight read separately by two persons. A part of the fine gold and all the copper constitute the first charge put into the melting pot, & after melting they are thoroughly stirred. ~~This first charge is thoroughly stirred,~~ because the wide difference in the specific gravity between gold and copper ($19\frac{2}{10}$ and $8\frac{9}{10}$) demands that the first charge be most thoroughly stirred to insure their perfect blending, because the smaller quantity allows of more ready stirring & ~~& thereby the a more easy incorporation with subsequent charges~~. The balance of the fine gold is next added, & after melting, the whole is again well stirred. Lastly any other standard metal or clippings is added, melted & the whole stirred. A portion of clippings is reserved to lower the temperature of the metal to the best casting heat, just before & during casting

This method of ~~first~~ melting all the copper with a part of the fine metal in the first charge secures a more perfect alloyage, than if all the fine metal and its copper had been melted at once, ~~because~~ moreover this first alloy having (over)

a much greater specific gravity than copper will blend ~~or~~ more readily with the still heavier fine gold next to be added.

¶ It is generally received as experience that the union of gold and copper is very firm, and that their alloy is scarcely liable to segregate into richer & poorer alloys, but I am unwilling to accept this conclusion as the result of my experience, without the following limitations. The presence of small quantities of foreign matters, antimony, &c. seems to increase the tendency of copper and gold to segregate. When gold & copper have been well alloyed by stirring in the crucible, there seems to be no tendency, or at most a feble one, to segregate, while kept melted or during casting; but when scraps or even bars of such well alloyed metal are again melted by a moderate heat, they do in fact often segregate into richer & poorer alloys.

Since stirring alloys is important to secure their perfect blending, (especially where the heavy melted gold is liable to cleave to the bottom of the crucible under the lighter copper) I contrived a black lead (as a stirrer) paddle with a few holes in the lower end, whereby the liquid metals are divided into many streams, and so more surfaces of contact being formed, the two metals are more & more rapidly certainly blended into one alloy. Experience confirms its efficiency.

Clean powdered charcoal, is continually kept on the surface of the metal during casting to prevent oxidation & burning off of copper; and to avoid loss by volatilization, the draft of the furnace is closed by a damper, so that any possible fumes

fumes ~~may~~ escaping into the ~~me~~ air of the melting room may deposit their metallic dust, & so pass into sweep. The ~~melted~~ mouth of the furnace is closed by ~~an arrange-~~ ~~ment termed~~ a "melting hood", consisting of a sheet of boiler iron, which fits over the whole opening, except that ~~a cylinder, is~~ open of the crucible, ~~inserted in the middle rests upon the to rim of the crucible~~. So that the caster is screened from all the heat of the opened furnace, except that radiating from the surface of the melted metal, which ~~he dips~~ the ladles last out with a black bad "dipping cup" held in tongs, & pours into the greased molds. For greasing, lard, lard oil, sperm oil, or petroleum are employed, the last being superior in cleanliness, keeping molds clean, & less liable to form the hard carbon deposit to which the others are liable.

The ingots coming hot from the molds are dipped for a few minutes into water, acidulated with sulphuric acid, whereby their surfaces are made clean & bright, & are then cooled & washed in ~~the~~ cold flowing water. After cutting off the tops (or pouring gates) of the ingots, and filing off their feathered edges, each ingot of a melt is stamped with figures representing the assay number of that melt from the beginning of the year.

Pieces are chipped off by the Assayer from the first and last ingot (cast) of a melt, marked 1 & 2 of that melt, and the result of their

of their assay, ~~determines is assumed to~~ determines whether the melt is of legal standard or not. If the two assays be sufficiently accordant, all the intermediate parts of the melt are assumed to be intermediate in fineness, & all experience has shown that this assumption is safe. The maximum & minimum fineness of our Gold ingots is rarely outside of 899.9 thou and 900.1 thou, and our practice is not to allow a greater variation than 899.7 thou and 900.3 thou, or a extreme deviation of $\frac{3}{10,000}$ (.0003) from the standard fineness.

Making Silver Ingots

Copper Alloy

The quantity of copper required to make silver coin of the U.S. legal standard, 900 thou, is different from ~~that for regal~~ what gold requires. First, because, when a silver ingot is cast in the act of congealing, a normal segregation throws of ~~copper~~ silver-copper alloys throws a richer alloy to the central line of the ingot, & a poorer outside of it; & therefore, since the coin are cut out from the centre, the whole ingot, & of course, the whole melt of ingots, must be made ~~poorer in~~ lower than 900 thou by an excess of copper in order to cut out the coin of 900 thou. — Second, because, ~~in the~~ while melting ingots, there is a tendency to ~~fuse~~ oxidize & burn off traces of copper, therefore ~~a trace more of copper should~~ sufficient copper should be added to replace this waste. Third, because, ~~in the~~ to clean the blanks before stamping they are plunged while hot into dilute sulphuric acid, whereby copper is extracted from the surface & to a depth depending on the strength of acid and time

. and time of immersion. I determined long ago from sheer experience that to obtain coin of 900m the alloy should not be above ~~but not~~ 899m, but the more direct & exact experimental determinations several years since by made Dr R.E. Rogers & myself proved that so much copper should be added to silver as to make the whole alloy average 898 3/4 m. We have followed this formula for some years, & the average fineness of 900m in our silver coin proves its soundness under present modes of working. ~~our melts of standard silver are ab weigh about~~ melting. We usually cast from each melt of standard silver about 3500 oz., which by topping & filing is reduced to about 3300 oz of ingots for the dollar & rather less for the quarter dollar. The melts are made in ~~No 70~~ Black Lead pots, No 70, of very full size, a loose black lead ring ~~of~~ (4 inches high) being put on the top of the crucible & the cover on the ring. This virtual elongation of the crucible encloses the whole of a commercial pig of silver, so as to exclude the sulphurous fumes of burning while melting, & the liquid metal sinks below the rim of the crucible ~~coal~~ anthracite. The ring offers the further advantage of allowing more thorough stirring without danger of splashing metal into the fire. A piece of black lead (usually the inverted bottom of an old crucible) is put in the bottom of the melting pot as a stool for the large rectangular pig to stand on while melting, lest

lest its weight, (100 lbs. more or less), should press the solid angles through the ~~bottom~~ sides of the crucible.

The ~~crucible~~ pot is charged similarly to that in melting gold, a part of the fine metal, if practicable, & all the copper being first charged, & melted, before the rest of the fine metal, & lastly the clippings are ~~the~~ put in. The little flux, ~~flux~~ which facilitates fusion, protects in a measure against oxidation & volatilization, & more or less prevents blistering, is skimmed off, when the fusion is complete & the metal well stirred, and its total removal is effected by the addition of fine charcoal, to which the remaining flux adheres, so that both are easily & completely skimmed off, leaving a brilliant surface of metallic silver

Casting. The metal is immediately covered with fine charcoal, which is continually added during casting, to replace what ~~what~~ burns off, so that in the atmosphere of carbonic oxide & acid, by the covering of charcoal, both oxidation & volatilization are measurably prevented. Although Silver, having half the specific gravity of gold, is more easily ~~stirred~~ stirred, so that a thorough blending of the metals into a homogeneous alloy is more certainly secured, nevertheless such is the strong tendency of standard silver alloy to segregate into richer & poorer alloys, both in the melting pot & in the act of congealing, that special precautions and watchful care are demanded to obviate the tendency

Segregation and True Assay of Coin-silver

The general fact of segregation of alloys at the time of congelation in a silver ingot of an alloy in the central line richer in silver, & on the outside and a law of distribution poorer in silver & therefore richer in copper was determined by the Assay Department of this Mint. This mode of segregation (long ago) we may term normal. & the difference between the centre & sides may be stated roughly at 1000. (over) Not many years since it was proved that the method in use up to that time, of chipping off a slip from the first & last ingot of a melt, for assay, did not give the true average fineness of the metal. The method was then adopted, which has ever since continued in use, when beginning to cast the metal after thorough stirring, to cast an ounce, more or less, into water to granulate it, and to do the same just before finishing the casting. The instantaneous congelation of the granulations prevents segregations, so that their assay represents the true fineness of the ingots. The uniformity in the assay results of these two granulations may be presumed to exhibit the true fineness of all the intermediate metal, if it has been often stirred. Even when this method is practised, the necessity of thorough & frequent stirring is shown by the fact, that a large mixture coin of different dates in the same year, each melt of which had been of standard fineness, and therefore the mixture the most perfect average of 900 practicable, was melted, stirred & granulated, as above, the 1st & last granulations showed a variation from each other of five thousandths

Segregation and True Assay of Coin-Silver

The fact of a tendency in alloys to segregate has long been known, and the law of segregation in an ingot of standard silver, when in the act of congealing, ~~has been~~ was long since determined in the Assay depart-
~~that is~~, ment of this mint, according to which ~~an~~ a silver-copper alloy, richer in silver, collects along the central column & a poorer one ~~on the~~ towards the outside. ~~This which we term~~ (We may term this termed this) normal segregation, ~~and the~~ in which the interior of an ingot is about 1000 richer in silver than the ~~next~~ exterior, & its ~~and~~ was regarded for a long time uniform, that pieces of ingots were chipped off from a certain part for assay, to determine whether the ~~coin would be~~ metal was of standard ~~or not~~. fineness for coin. A few years since it was proved that ~~the~~ ~~this mode~~ such assay did not represent truly the fineness of the ingot & therefore of ~~the~~ coin. In fact segregation has been more irregular latterly than formerly, & is in my ~~belief due~~ opinion due to the more frequent presence of small quantities of foreign metals, antimony, bismuth, &c. which render segregation more abnormal. ~~than formerly~~.

thousandths (.005), fairly ascribed to the melter having waited some time after stirring before casting the granulations. To test this, the same metal was again melted & kept stirring during the whole casting, when the resultant assays of the 1st and last granulations were practically identical, & that was good.

Remedy for Abnormal Segregation

~~Stirring Silver Ingot Melts.~~

~~Prevention Segregation and Remedy for~~

Stirring silver ingot melts immediately before casting is of sufficient importance to demand a more detailed description of the method of remedying segregation. It is the more important at present, because most of the commercial silver from the Refineries retains a small percentage (one or more thousandths) of base, & usually embrittling, metals, Arsenic, Antimony, Bismuth, Lead, &c. which, in my view, tend still more strongly to induce the segregation of silver-copper alloys, than if pure silver & copper alone were present. The moment the melted alloy becomes quiet, segregation begins. It is therefore necessary not only to stir the metal just before beginning to cast, but to keep up the agitation without ceasing until all the metal is cast out. This is effected during casting, specially by a stirrer, or by thrusting the dipping cup up & down through the melted metal, or by dipping a cup of melted metal, & pouring it from a little height into the balance of the metal in the pot.

Even after the above precautions we always leave a portion of silver (200 @ 300 oz) in the ~~pot~~ melting pot for the next melt, because the length of time required to dip out the last remnants by driblets would be most likely to induce segregation, and would certainly expose the silver to volatilization, For as the silver in the pot diminishes, while the fire remains the same, the relatively greater bulk of the fire has the effective result of increasing the heat even rising to a greater volatilization of silver.

Standard Silver Ingots. When cast, the silver ingots are treated similarly to those of gold, dipped into diluted sulphuric acid, washed, topped, filed on their edges, wiped & dried, the only difference being that only the top layer of ingots in a box, ~~not the~~ are stamped with the number of the melt, & not every ingot. Since an ingot of the fineness $898\frac{3}{4}$ will make coin of 900, it is the usual practice of the Assayer, not to certify to the legality of ingots outside of 898 or 900; In point of fact the standard of a large proportion, say nine-tenths $(\frac{9}{10})$, of our silver ingots fluctuates between $898\frac{1}{2}$ and $899\frac{1}{2}$, far within the legal limits; and hence the uniformly close approach of our coin to 900.

Transference of Ingots & Clippings

The Superintendent mediates in transferring Ingots from the melter

. the Melter & Refiner to the Coiner, and Clippings
. from the latter to the former, all three officers or their
. delegates being present at ~~or~~ the whole time of and during each transfer.
. The Supt dt's ~~dele~~ clerk weighs the bullion; each of the three
. deputies reads & ~~puts~~ notes down the weight, after which
. the weight is read aloud. Disagreement in weights is
rectified by reweighing. Melts of gold ingots are
weighed singly, but melts of silver in masses of some
5000 oz. each. The entries in their respective books con-
sist of the date of entry, the number of the melt, if gold,
the number of the draft at that weighing, the description of
the bullion, (clippings, ~~Gold~~ number & denomination
of ingots), and the weight. At the close of the transfer, the
sum of ingots, and of ounces is noted by each delegate, and
then read aloud, so as to secure the accuracy of the whole
transfer. Summaries of deliveries are compared monthly
or of tener.

Full receipts are given at the close of each delivery,
by the Supt dt. to the M. & R. for Ingots ~~& Bars~~ and Fine Bars,
and by the M. & R. to the Supt dt. for clippings.

Daily Record of Melting Bullion.

An account is kept by the M. & R. against the Master
Melter of the amount of bullion sent to the Melting room each

. each morning, such as, the residues from the previous day's work, clippings sent out to be melted, melts made up with the due proportion of ~~[illegible]~~ alloy, and other bullion calculated and made up by copper or fine silver ~~to~~ (as the case may be) to the standard of 898 3/4. The master melter is debited with all the above. At the close of the day, he is credited with all the residues, with the weight of ingots made, (when delivered to the Supt dt.), ~~&~~ of any condemned melts, & of the grain-bar of that day. To render the account more truthful and exact, all the items above-named are calculated to the regular standard, 900, the ingots, bars & tops, filings, & prepared melts being assumed at 899, the clippings at 898, & the rest ~~calculated~~ calculated at the ~~reported~~ fineness ~~of the repor~~ reported by the Assayer. The balance between the debit and credit accounts show the losses of the day's work with sufficient nearness to truth to determine whether they are usual or excessive. The only items omitted from this daily account are the (daily bar of) grains (not known until the 2nd or 3rd day after melting), a bar of general grains, determined once a month, the assay-slips, (bullion adhering to iron utensils, grate bars, &c) and the sweep.

over

Daily Grains. At the close of a day's work, the sweepings of the stone floor under the iron-grated floor, from near the furnaces & filing benches, & the slags skimmed from all the melts of the day, are put into an old melting pot, & left to king in a

Assay Slips. : An account is kept by the Assayer of the ~~Bars~~ daily Slips cut off from Ingots & other bullion in the hands of the M. & R., but as portions of these pass into solution in the course of the assay, & as it would be impracticable to recover these trifling items daily, a cumulated return of these Slips is made by the Assayer to the M. & R. once or twice a month.

in a good fire. On the following morning the slag on the king, the furnace ashes, & the worn out ~~pots~~ crucibles of the previous day, are ground & sifted in the sweep cellar, making coarse grains and finer powder. This finer powder when washed, yields fine grains & sweep, the former of which is gathered from the washing machine on the 2nd (second) morning after melting, and dried. The ~~king~~ fine & coarse grains, and the king, are together melted into a bar, termed the grain-bar, which is stamped with the consecutive number from the beginning of the year, & credited to the master-melter for the previous day's work. ~~The slags from the grain melting helps to form a bar of general grains for the month. at the close of the month,~~ All the daily grain bars of the month are, at its close, melted into ~~one~~ or more bars, called Consolidated Grains, (standard weight, calculated from ~~the~~ its) whose weight & assay, ~~&~~ confirms the sum ~~of the sum~~ of the standard weights of the separate bars

Bar of General Grains. The slags and crucibles from melting the daily grain-bars, are ground & sifted, and their grains, together with the residues of silver, from dipping ingots in dilute sulphuric acid, & any other residues, are melted at the close of the month into one or more bars termed General Grains. These always diminish ~~in an important proportion~~ to a large extent the ratio of the apparent daily losses

losses, which are further reduced by the sweep and the amalgam.

~~Separation~~ Sweep of Iron residues. ~~When a pot~~ By the In the use of tongs & other iron utensils, or when a pot of melted metal breaks over the grate-bars, the bullion adhering to the iron is removed, as far as practicable, by cutting & scraping at the time, & is put among the remaining grains. The iron containing traces of ~~the metal~~ bullion is reserved from several such operations to be worked at one time, to recover all the precious metal. The ~~simple~~ former method ~~is to melt and king the whole, with sufficient carbon~~ of recovery ~~was to heat~~ by heating the iron to full redness, until all the ~~scales~~ parts containing bullion were scaled off by the hammer, caused a loss of bullion by long heating in the fire, and usually three days of labor by a large force of men, once a year. The second process, which I contrived, ~~was~~ to ~~unite~~ sulphuret ~~of iron~~ the iron, and to remove ~~the sulphuret~~ it again by solution in acid, leaving the gold and silver untouched, was more easy of execution, & saved loss of bullion, but was rather too costly in acid. I then contrived the method now ~~adopt~~ employed, in which by ~~to~~ melting the iron well carburized and ~~king it~~ allowing to king in a slowly lessening fire, the bullion will be found in a layer under the iron, & entirely separate, & easily detached from ~~each other~~ it. These pieces of bullion ~~are~~ usually ~~brought into~~ pass to the credit of the M. & R. once in the year, or as often as obtained.

Sweep.

The residues of grinding, noted above as finally passing through sieves (up to No 60) in a dry state, are passed through a washer & amalgamator, suspended in a constant stream of water, from which the fine grains (as above noted) deposite. The stream, with the still finer balance, is forced, under constant stirring, through mercury, which takes up a portion of gold & silver. The pressed amalgam is usually distilled once in a month, and its melted bar assayed, numbered & named Amalgam-bar. The fine matter, passing from the mercury, is sweep suspended in water, and flows into & through a settling tank, a wooden box lined with sheet-lead, & divided into three compartments by partitions of sheet-lead.